International Association for Geomagnetism and Aeronomy
DIVISION V: GEOMAGNETIC OBSERVATORIES, SURVEYS AND ANALYSES

A new IAGA index for description of polar cap magnetic activity

In July 1999, during the 22nd General Assembly of the International Union of Geodesy and Geophysics (IUGG) in Birmingham, UK, the International Association of Geomagnetism and Aeronomy (IAGA) thoroughly considered and then officially adopted the Polar Cap (PC) Magnetic Activity Index as the IAGA index of geomagnetic activity in the polar regions. This index was initially proposed in 1979 (see the index's description below) and therefore it has been in use for 20 years. Geomagnetic variations recorded continuously at the two near-pole magnetic observatories, Qaanaaq (Thule) in Greenland and Vostok in Antarctica, are utilized in producing the Northern and Southern PC-indices on a regular basis at the Danish Meteorological Institute (DMI, Copenhagen, Denmark) and the Russian Arctic and Antarctic Research Institute (AARI, St. Petersburg, Russia).

It was recommended by IAGA that the service should be continued if possible for both the Northern and Southern polar caps. Dr. David Kerridge, President of IAGA, submitted this request to the DMI and AARI Directors to confirm the institutional commitments. Their responses were positive assuring IAGA that there are no plans to discontinue this service.

Thus we are happy to announce that the Polar Cap (PC) index is now accepted as the official IAGA index for describing geomagnetic activity over the polar caps. Currently both the Northern and Southern PC indices are available on-line via the World Wide Web: from DMI – http://www.dmi.dk/projects/wdcc1/pcn/ and from AARI – http://www.aari.nw.ru, respectively. More information about all IAGA indices of geomagnetic activity can be found at the International Service of Geomagnetic Indices (ISGI) Web site http://www.cetp.ipsl.fr/~isgi/homepag1.htm.

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Polar Cap (PC) Magnetic Activity Index

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The PC-index has been introduced by *Troshichev et al.* [1979, 1988] as an index for monitoring geomagnetic activity over the polar caps caused by changes in the interplanetary magnetic field (IMF) and solar wind. *Troshichev and Andrezen* [1985] have shown that ground geomagnetic disturbances measured at a single near-pole station highly correlate ($r > 0.8$) with the "merging electric field" E_m applied to the Earth's magnetosphere [*Kan and Lee*, 1979]:

$$E_m = V_{SW} B_T \sin^2(\theta/2) = V_{SW} (B_y^2 + B_z^2)^{1/2} \sin^2(\theta/2)$$

Here V_{SW} is the solar wind velocity, B_y and B_z are the IMF azimuthal and vertical components, respectively, and θ is the IMF "clock-angle" measured between the Earth's magnetic field vector and B_T.

The algorithm to derive the PC-index is based on a statistical analysis of the relationship between variations in E_m and geomagnetic perturbations ΔF at the Earth's surface. Two near-pole magnetic observatories were proposed for derivation of the index: Qaanaaq (Thule) in Greenland at 85.4° corrected geomagnetic (CGM) latitude and Vostok in Antarctica at –83.4°. Since a near-pole station is located under the sunward, transpolar portion of the two-cell ionospheric current system DP2, observed magnetic perturbations point approximately towards dusk. The exact direction is slightly varying in time because DP2 is somewhat skewed with respect to the noon-midnight meridian. Thus, the transverse magnetic perturbation caused by the DP2 transpolar current can be written as:

$$\Delta F_{PC} = \Delta H \sin\gamma \pm \Delta D \cos\gamma$$

where $\gamma = \lambda \pm D_E + \varphi + UT \cdot 15°$. Here ΔH and ΔD are deviations in the ground horizontal H and D magnetic field components from the pre-selected quiet level, D_E is the station's average declination angle, λ is its geographical longitude, and φ is the UT-dependent angle between the DP2 transpolar current and the noon-midnight meridian. "+" is used for Vostok, and "–" for Qaanaaq. The quiet level is deduced for Qaanaaq by interpolating between field's values determined at nighttime hours of quiet winter days in the two consecutive years. The quiet level for Vostok is determined from quiet days for the examined month.

The "true" angle φ is obtained through a correlation analysis relating E_m and horizontal magnetic perturbations projected on various directions; the direction where correlation is maximal is then used for derivation of the index. Figure 1 shows optimal directions obtained at Vostok and Qaanaaq (Thule)

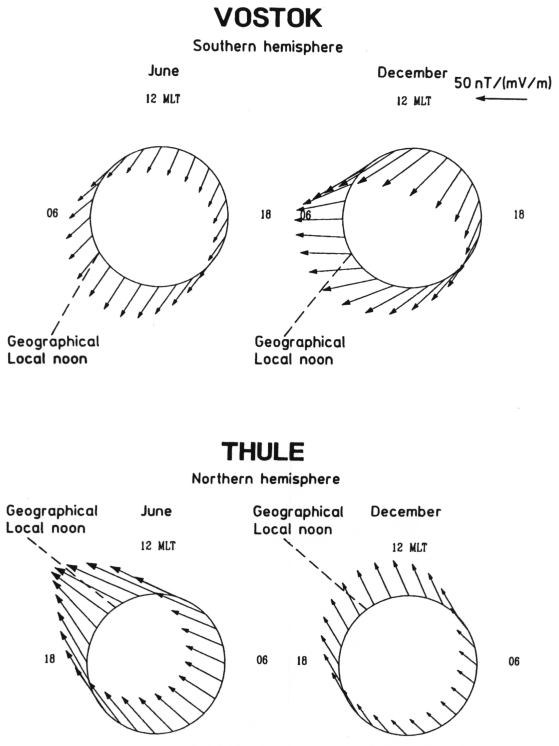

Figure 1. The CGM latitude - MLT diagram for the selection of optimal directions in the PC index derivation [after *Vennerstrøm et al.*, 1994].

for June and December. It was found that these optimal directions vary with UT and season; therefore, the projected horizontal perturbation ΔF_{PC} should be normalized with respect to E_m:

$$\Delta F_{PC} = \alpha \cdot E_m + \beta \quad \text{and} \quad PC = (\Delta F_{PC} - \beta) / \alpha \cdot \eta$$

where α (slope) and β (intercept) are functions of local time and month, and η = 1 mV/m is a normalization coefficient required to make the PC index dimensionless. The PC index is now calculated from a set of 12 (months) by 24 (hourly) values of the coefficients α and β and angles φ. These coefficients have independently been determined for Qaanaaq and Vostok for the period when good coverage of the IMF data has been available. For example, Figure 2 shows contour plots of the coefficients α and β obtained for Thule as functions of the months and UT hour. Further investigation of the PC-index is underway [e.g., *Papitashvili and Rasmussen*, 1999; *Troshichev et al.*, 2000]

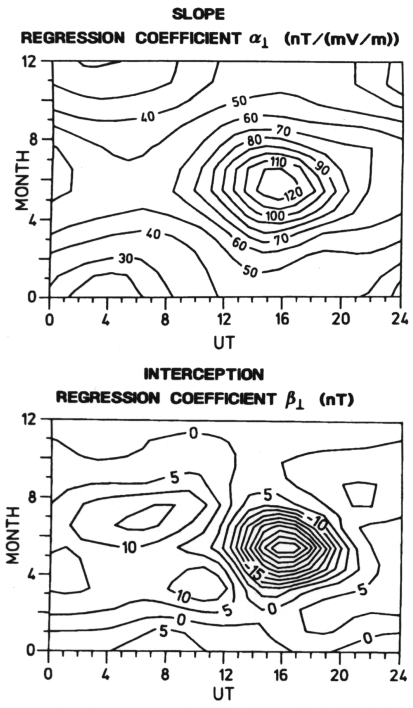

Figure 2. Contour plots of regression coefficients α and β [*after Vennerstrøm et al.*, 1994].

The World Data Center B2 (Moscow, Russia) and the NOAA National Geophysical Data (Boulder, Colorado, U.S.A.) have published the index catalogs [e.g., *Troshichev et al.*, 1991; *Vennerstrøm et al.*, 1994]; NGDC has also made PC-index available through regular publications. Currently the Northern PC index is continuously derived from geomagnetic data obtained at Qaanaaq; the Southern PC index – from geomagnetic data obtained at Vostok. Both indices are available on-line from the Danish Meteorological Institute (Copenhagen, Denmark, http://www.dmi.dk/projects/wdcc1/pcn) and from the Arctic and Antarctic Research Institute (St. Petersburg, Russia, http://www.aari.nw.ru).

The International Association of Geomagnetism and Aeronomy (IAGA) has officially adopted the Polar Cap (PC) Magnetic Activity Index at the 22nd General Assembly of International Union of Geodesy and Geophysics (IUGG, Birmingham, UK, July 1999). It has been recommended by IAGA that the service should be continued for both the Northern and Southern polar caps in near future upon availability of resources at DMI and AARI.

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